

A UNITED STATES
DEPARTMENT OF
COMMERCE
PUBLICATION

September 1970

NATIONAL BUREAU OF STANDARDS

Technical News Bulletin



Hazardous Noise Levels in Computer Labs



Improved Semiconductor Resistivity Measurements

UNITED
STATES
DEPARTMENT
OF
COMMERCE

1. NOVEMBER 30	30 NOV
2. AUGUST 14	14 AUG
3. APRIL 8	8 APR
4. JUNE 14	14 JUN
5. OCTOBER 22	22 OCT
6. JANUARY 9	9 JAN
7. DECEMBER 12	12 DEC
8. AUGUST 27	27 AUG
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11. DECEMBER 31	31 DEC
12. OCTOBER 13	13 OCT
13. FEBRUARY 2	2 FEB
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NBS Provides Random Tables for Draft Lottery



NATIONAL BUREAU OF STANDARDS

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SEPTEMBER 1970 / VOL. 54, NO.9 / ISSUED MONTHLY

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BULLETIN

Radio Stations WWV and WWVH

The transmissions from WWV and WWVH are being interrupted intermittently during September and October to carry out antenna measurements. The interruptions are brief and affect only one frequency at a time. Both stations are making voice announcements about this between three and four minutes after each hour starting at 0000 UT on September 1, 1970, and continuing until about November 1, 1970.

Nat. Bur. Stand. (U.S.), Tech. News Bull.
CODEN:NBSTA 54(9) 193-216 (1970).

Superintendent of Documents Catalog No. C13.13:54/9

Library of Congress Catalog No. 25-26527

U.S. DEPARTMENT OF COMMERCE

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NATIONAL BUREAU OF STANDARDS

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The National Bureau of Standards serves as a focal point in the Federal Government for assuring maximum application of the physical and engineering sciences to the advancement of technology in industry and commerce. For this purpose, the Bureau is organized as follows:

- The Institute for Basic Standards
- The Institute for Materials Research
- The Institute for Applied Technology
- Center for Radiation Research
- Center for Computer Sciences and Technology

The TECHNICAL NEWS BULLETIN is published to keep science and industry informed regarding the technical programs, accomplishments, and activities of NBS.

For sale by the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402. Annual subscription: Domestic, \$3; foreign, \$4; single copy, 30 cents. Use of funds for printing this publication approved by the Director of the Bureau of the Budget (June 22, 1966).

THE PSYCHOPHYSICAL SIDE OF SOUND

Subjects for psychoacoustic studies are isolated inside an acoustically and magnetically shielded booth. Eudora Gray (left) notes the stimulus applied while Donna Free monitors responses of Linda Hawkins, in booth. All three are participants in the Summer Aides Program at the Bureau.



THE PHYSICAL CHARACTERISTICS of various sounds are well known, but methods and procedures for assessing their effects on people are still disputed. The Sound Section of the NBS Institute for Basic Standards is attacking the disparity among the several psychoacoustic measurement methods in a new program of basic psychophysical research directed by John A. Molino. The psychological responses of human subjects to experimentally controlled sounds will be assessed in this program and the responses correlated with the physical parameters of the stimuli.

Procedures and standards for measuring sound in different areas are at variance. Widely used in the United States is a method for determining loudness (ANSI * S3.4) developed by S. S. Stevens,¹ while the German standard (DIN 45631) uses a method proposed by E. Zwicker.² The International Standards Organization's recommendation (ISO 532) offers the choice of either method. The Federal Aviation Administration, on the other hand, adopted still a third procedure (Noise Rule: Part 36) using the Karl Kryter method for estimating noisiness.³ Thus, an aircraft may be certi-

fied for noise generation by measurements made under one standard and its contribution to noise pollution measured under another standard.

To further compound the problem, the three methods yield results that not only are disparate among themselves, but correlate poorly with judgments made by "juries" of subjects. None of the three methods is able to predict the subjective reactions of man to many of the complex sounds encountered in our daily lives. Measuring these sounds realistically has an essential place in appraising the amount of noise pollution in our urban environment.

Much of past auditory research has been performed at universities, which make up for any shortcomings in equipment and calibration capabilities by having access to a large pool of young subjects with keen hearing. The NBS program now being undertaken will benefit not only from the measurement expertise of the entire Sound Section, but will also have available as subjects high school students employed at the Bureau under the Summer Aides Program.

Aides volunteering to serve as subjects will be placed in a soundproof booth, where they will be exposed to audible stimuli with experimentally

varied parameters. In the present test the subject hears two tones of different pitch and is asked to adjust the amplitude of one so both sound equally loud. The test technicians themselves are Summer Aides, a fact which should help to maximize subject identification with the project. These technicians schedule the subjects, introduce them into the experiment, present the programmed stimuli, and record and process the data.

By employing new methods such experiments will provide more information on the loudness and aversiveness* of simple acoustic stimuli. Future experiments will synthesize complex sounds from these simple components and measure the variables of context motivation and adaptation as they affect subjective judgments. Findings in this area will be of great interest to acousticians and psychologists.

*Aversiveness is a quality attributed by psychologists to a stimulus when behavioral measurements produce an avoidance or escape response.

¹ Stevens, S. S., Procedure for calculating loudness; mark VI., J. Acoust. Soc. Am. 33, 1577-1585 (Nov. 1961).

² Zwicker, E., Ein Verfahren zur Berechnung der Lautstärke, Acustica 10, 304-308 (July-Aug. 1960).

³ Kryter, K., Concepts of perceived noisiness, their implementation and application, J. Acoust. Soc. Am. 43, 344-361 (Feb. 1968).

*American National Standards Institute.

NBS PROVIDES RANDOM TABLES FOR USE IN DRAFT LOTTERY

SCIENTISTS AT THE NATIONAL BUREAU OF STANDARDS provided the random tables for, witnessed, and attested to the impartiality of the draft lottery conducted by the Selective Service System on July 1, 1970. Sets of 25 "random calendars" and 25 "random permutations" were prepared by Drs. Joan Rosenblatt and James Filliben of the NBS Statistical Engineering Laboratory (SEL). The random sets were derived from tables published by Moses and Oakford¹ and tested for randomness by Drs. Rosenblatt and Filliben, in consultation with Dr.

Churchill Eisenhart and Joseph Cameron of NBS, both former Chiefs of the SEL now headed by Dr. Rosenblatt. In addition, a distinguished panel of statisticians examined and endorsed the procedures used by NBS in evaluating the randomness of the tables.

The essence of the present Selective Service System is that potential inductees are called for induction in a random order based on birthdates. The July 1 drawing established the order in which men born in 1951 will be called. The Selective Service Sys-

tem, in preparing for the drawing, asked NBS to provide 25 random calendars, and 25 random permutations* of the numbers 1 through 365. The Bureau has long been active in the field of mathematical statistics, with its work on the generation of random numbers and on the Monte Carlo method dating from 1948. Tables 1 and 2 show the format in which NBS provided the calendars and permutations, each example being but a part of the complete table that was actually used in the Selective Service System procedures.

In responding to this request NBS used a book of random permutations that was widely available, rather than to generate new tables by computer. As not all of the tables in the book were evaluated by the authors, NBS performed statistical tests for randomness² according to the criteria established by Moses and Oakford. The tables were found to be satisfactory by these and by other criteria as well. Techniques for checking the accuracy of punched cards and computer calculations, based on experience gained in preparing mathematical tables such as those appearing in the NBS Hand book of Mathematical Functions,³ were employed by NBS throughout the preparation of the calendars and permutations. The randomness tests were done on the NBS computer, after the tables from the book had been punched and verified under the direction of Mrs. Linda E. David, Systems Division, Bureau of the Census.

The independent panel that evaluated NBS procedures consisted of three former presidents of the American Statistical Association: Dr. A. H. Bowker, Chancellor, City University of New York; Dr. Morris H. Hansen, Westat Research Inc., Bethesda, Md.; and Professor Frederick F. Stephan, Department of Statistics, Princeton University. The panel convened at NBS on June 23 to formally appraise and endorse the NBS procedures, hav-



Drs. Joan Rosenblatt and James Filliben examine the results of tests for randomness.

*The number of different arrangements—or permutations—of the numbers 1 to 365 is approximately 25×10^{77} .

ing been sent a description of the procedures prior to the meeting.

At the panel meeting a system starting with a throw of 3 dice led to a completely objective selection of 25 random calendars and 25 random permutations from the 78 prepared from Moses and Oakford. Those selected were placed in envelopes in such a way that no one knew what table was in what envelope.

The random calendars and random permutations were used by the Selective Service System in an elaborate procedure to insure objectivity. The procedure, in outline form, was:

1. A witness chose the color of capsule into which the dates were to be placed from among two choices. (There were 2 racks containing 365 capsules; all capsules on one rack were red and those on the second rack were green.)

2. A second witness chose one of the 25 random calendars.

3. Using the calendar, the dates were placed in the capsules and the capsules returned to the rack.

4. A random permutation was selected by which the numbers 1-365 were placed in the second set of capsules.

5. A third random permutation was selected and determined the order by which the capsules containing the dates and numbers were placed in two containers.

6. At the drawing ceremony, after considerable rotating of the two containers, one individual selected a date capsule from one drum while a second selected a number capsule from the other drum. This drawing of dates and numbers continued until the entire calendar was permuted. The numbers assigned to dates determine the order in which potential draftees are to be called.

¹ Moses, L. E., and Oakford, R. V., *Tables of random permutations*, Stanford University Press, 1963.

² A detailed description of the NBS procedures will be formally published later.

³ *Handbook of Mathematical Functions*, NBS Applied Math. Series 55, 1964. Available from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402, for \$6.50.

RANDOM CALENDAR PREPARED BY THE NATIONAL BUREAU OF STANDARDS FROM MOSES AND OAKFORD, PAGES 204 AND 205

1.	NOVEMBER 30	30 NOVEMBER	11/30	334
2.	AUGUST 18	18 AUGUST	8/18	230
3.	APRIL 8	8 APRIL	4/8	98
4.	JUNE 14	14 JUNE	6/14	165
5.	OCTOBER 22	22 OCTOBER	10/22	295
6.	JANUARY 9	9 JANUARY	1/9	8
7.	DECEMBER 12	12 DECEMBER	12/12	346
8.	AUGUST 27	27 AUGUST	8/27	239
9.	SEPTEMBER 20	20 SEPTEMBER	9/20	263
10.	SEPTEMBER 8	8 SEPTEMBER	9/8	251
11.	DECEMBER 31	31 DECEMBER	12/31	365
12.	OCTOBER 13	13 OCTOBER	10/13	286
13.	FEBRUARY 2	2 FEBRUARY	2/2	33
14.	MAY 15	15 MAY	5/15	135
15.	OCTOBER 20	20 OCTOBER	10/20	293
16.	OCTOBER 4	4 OCTOBER	10/4	277
17.	APRIL 16	16 APRIL	4/16	106
18.	NOVEMBER 3	3 NOVEMBER	11/3	307
19.	JUNE 20	20 JUNE	6/20	171
20.	AUGUST 23	23 AUGUST	8/23	235
21.	MAY 3	3 MAY	5/3	123
22.	OCTOBER 9	9 OCTOBER	10/9	282
23.	MAY 2	2 MAY	5/2	122
24.	JUNE 1	1 JUNE	6/1	152

Table 1.

RANDOM PERMUTATION PREPARED BY THE NATIONAL BUREAU OF STANDARDS FROM MOSES AND OAKFORD, PAGES 194 AND 195

1.	348	348
2.	306	306
3.	277	277
4.	291	291
5.	162	162
6.	333	333
7.	5	5
8.	289	289
9.	325	325
10.	324	324
11.	360	360
12.	3	3
13.	295	295
14.	248	248
15.	241	241
16.	6	6
17.	145	145
18.	310	310
19.	36	36
20.	261	261
21.	85	85
22.	187	187
23.	253	253
24.	204	204
25.	7	7
26.	32	32

Table 2.

IMPROVED SEMICONDUCTOR RESISTIVITY MEASUREMENTS

A MAJOR PROBLEM OF THE SEMICONDUCTOR INDUSTRY—that of characterizing single crystal silicon and germanium through reliable resistivity measurements—has largely been solved through the efforts of the semiconductor technology laboratories¹ in the NBS Institute for Applied Technology. The NBS program, sponsored by several Government agencies and carried on in cooperation with the industry,* led to improvements in measuring specimen resistivity by means of a four-point probe, a method incorporated by the American Society for Testing and Materials in procedures now in the final stages of approval. Using the new procedures, the semiconductor industry is able to characterize its materials with improved precision and accuracy, thereby wasting less material and improving product uniformity.

Resistivity Measurements

Resistivity is the semiconductor characteristic used most widely in material procurement and evaluation, and in process control of both material and semiconductor devices. This is because resistivity can be an indicator of the density of free carriers, a parameter on which the electrical characteristics of semiconductors depend. Despite the apparent simplicity of resistivity measurements, problems

and disagreements concerning proper methods and precision have plagued the industry for years. In 1960, the ASTM Committee F-1 on Materials for Electron Devices and Microelectronics asked the Bureau to investigate the difficulties encountered in measuring resistivity of germanium and silicon, the semiconductors of major industrial importance. The Bureau began work on this project by investigating problems facing the industry and by conducting a literature search to identify all measurement methods then known.²

Two methods of measuring semiconductor resistivity were then (and still are) in use. In both, the dependent variable is the voltage developed along part of the path of a known current through the specimen. One method, using a two-point probe, requires more time for specimen preparation, but it was felt by many users to offer more precision. The specimen normally used for a two-probe measurement is a parallelepiped cut from the sample of material with metal contacts plated on its two ends, making of each an equipotential plane. When the contacts are connected to the current source, the current density is assumed to be uniform in all intermediate planes and a constant voltage gradient to exist between the planes, provided the sample is homogeneous.

If the potential difference between two planes is measured, the resistivity can be calculated from the voltage-current ratio and the specimen's dimensions. For homogeneous specimens, the accuracy of the

determination depends, in principle, only on the accuracy with which the voltage, current, and dimensions are measured.

A four-point probe technique, originally developed at the Bureau to make conductivity measurements of the earth's surface, was adapted by the industry for use with semiconductor materials. Electrical connection is typically made to the semiconductor material by applying a probe bearing the four contact points 1.6 mm apart on a straight line. Current is passed between the two outer points through the material and the potential difference developed between the inner points is measured. The voltage-to-current ratio is converted to a resistivity value by use of constants of proportionality developed for specimens having finite areas. Other correction factors that are used directly correlate two- and four-point probe measurements on a parallelepiped specimen were developed at the Bureau.³ The Bureau also prepared correction factors for both in-line and square probe arrays placed off-center on wafers of certain dimensions.⁴

The original intent was for the Bureau to send out specimens of certified resistivity for calibrating probes, but a study showed that available materials were not uniform enough to provide the accuracy and reproducibility required by industry. A significant finding of this study was that reproducibility of measurements by the four-point probe appeared to be as good as that of the two-point method. Because of the greater ease

*This NBS program has been supported at various times by the U.S. Air Force Cambridge Research Laboratories, the Advanced Research Projects Agency of the Department of Defense, and NASA's Electronic Research Center. In this work the Bureau has had the aid of the semiconductor industry particularly in the programs of the American Society for Testing and Materials.

of using the four-point probe, further work was aimed at developing procedures, equipment, and safeguards for its use that would assure maintenance of the reproducibility needed in industry.

Improved Procedures

Sources of poor measurement reproducibility include such major factors as a lack of standardization in preparing the surface, in selecting the probe contact material, and in positioning the probe. The Bureau overcame these problems by recommending that the wafer surface be lapped with 5- μ m abrasive and that a 175-gram load on each tungsten carbide probe point be applied when the probe was in position. This method gives satisfactory results without undue wear or wandering of the probe points.

Because measured resistivity values are dependent on the temperature (having linear coefficients of as great as 1 percent per degree Celsius), the specimen must be temperature-stabilized. A silicon wafer placed on a massive copper block assumes the block's temperature rapidly—in about half a minute—even if separated from it by a thin mica layer. This method of temperature stabilization is used at the Bureau and the temperature of the block (between 18 and 28 °C) is determined for converting the resistivity values to those for a standard temperature, 23 °C. During the course of this work the Bureau published much-needed values of temperature coefficients of a variety of germanium and silicon specimens near room temperature.⁵

Once surface preparation and probe force were standardized, the Bureau worked out a way for the user to determine the extent of probe wander and deviation from ideal probe point spacing. A similar spacing test was incorporated by the ASTM Committee F-1 into a standard resistivity measurement method.

The ASTM procedure also included the use of a resistive test fixture to be substituted for the probe and spec-

imen to calibrate resistivity indicators. The resistors for some of the Bureau's test fixtures had to be designed and fabricated especially for this application by NBS engineer Frank H. Brewer. These resistors were designed to minimize both the temperature coefficient of resistivity

and thermoelectric voltages.

Effectiveness

ASTM Committee F-1 asked cooperating laboratories to use and report on the improved measurement procedures resulting from the Bureau's work when applied to silicon



Frank Brewer connects a standard resistive network (small box) to a resistivity indication instrument to check instrument operation. During calibration, this test fixture replaces the probe (background) used in measuring the resistivity of semiconductor materials.



Donnie Ricks places a wafer of silicon on a copper heat sink in preparation for measuring the specimen's resistivity.



Leonard Smith uses a probeholder, which he designed and built, to bring the probe into contact with the specimen so gently that the danger of damage is nearly eliminated.

crystals. It was found that experienced laboratories reproduced resistivity measurements of 0.01 to 100 Ω -cm with a standard deviation of less than 1 percent. Less experienced laboratories obtained poorer results, reporting difficulties involving, in most cases, the sensitivity and accuracy of measuring equipment not meeting requirements of the procedure. This testing showed the usefulness of controlled laboratory environments and performance tests of the probe and measuring system.

The resistivity measurement procedures developed at NBS increased measurement precision by an order of magnitude over that formerly obtained. What this means in dollars was appraised by Judson C. French with the cooperation of companies using the new procedures, in a benefit/cost analysis of the use of this method in measuring resistivity of single-crystal silicon. The benefits were those expected in industry for a ten-year period beginning in 1967, quantified as potential savings at the buyer-seller interface. The cost of the improvement was considered to be the cost of this program at NBS, making allowance for industry's part in development of the procedures.

Data for the analysis were found by interviewing personnel in the semiconductor industry—principally suppliers and users of semiconductor materials. Substantial savings were found in reducing the number of instances when resistivity measurements by the buyer and seller disagreed, nullifying a sale and leading to scrapping of the disputed material. Other benefits were omitted from consideration because they were impossible to appraise; these included benefits in "captive" markets and in reducing out-of-tolerance production by using the procedures in process control. The study found the benefit/cost ratio to be 110; the Bureau's investment will pay off a hundredfold.

Simplified Instrumentation

Routine four-point probe resistivity measurements on thin wafers can be

made quickly and easily by a direct reading instrument designed by the Bureau's Lydon Swartzendruber, Frank Ulmer, and Joseph Coleman.⁶ It consists of a meter and switchable resistive networks that can be set to values that compensate for effects of the diameter and thickness of the specimen and the location of the probe on the specimen.

The resistivity meter is used by dialing in the specimen thickness and diameter, dialing in the probe displacement from the specimen center, selecting the resistivity range (thereby setting the current), lowering the probe to the specimen, and reading the resistivity from the meter. Although this instrument is not sufficiently precise for use at the buyer-seller interface, it is useful in routine testing in connection with device fabrication.

Achievement of the desired precision places extreme demands on the probeholder. If the probe slips sideways as it touches the specimen, contact spacing is altered. Needed was a massive, stable carriage for lowering the probe to the specimen without lateral displacement, one with sufficient sensitivity to avoid any danger of fracturing the specimen.

To meet these requirements, Leonard Smith, an NBS engineering technician, designed and built a new probeholder. During positioning the probe is brought nearly to the specimen surface by a rack-and-pinion drive on the probeholder support column and then is advanced to make contact by a lever rotating a spring-loaded cam. At this point the pressure of the electrical contact is determined by individually adjusted springs inside the probe. The user of the new probeholder can position the probe without skidding more easily than with previous probeholders, and in a reproducible manner as well.

Present experimentation is directed toward extending the range of the four-point probe method to higher and lower resistivities. The scientists are interested also in finding the effect of different currents and probe forces

on the resistivity measurements of specimens with surface conditions such as those encountered on epitaxial and diffused semiconductor layers. Measurements on these layers present special problems because the layers are so thin that their surfaces cannot be prepared for measurement in the normal way without damage.

¹ Bullis, W. M., *Measurement Methods for the Semiconductor Device Industry—A Summary of NBS Activity* (Dec. 1969), Nat. Bur. Stand. (U.S.), Tech. Note 511, available from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402, for 30 cents. Order by SD Catalog No. C13.46:511.

² French, Judson C., *Bibliography on the Measurement of Bulk Resistivity of Semiconductor Materials for Electron Devices*, Nat. Bur. Stand. (U.S.), Tech. Note 232 (Oct. 1964).

³ Swartzendruber, L. J., *Calculations for Comparing Two-Point and Four-Point Probe Resistivity Measurements on Rectangular Bar-Shaped Semiconductor Samples*, Nat. Bur. Stand. (U.S.), Tech. Note 241 (June 1964). Available for 25 cents from the above source as SD Catalog No. C13.46:241; and Reber, J. M., *Potential distribution in a rectangular semiconductor bar for use with four-point probe measurements*, *Solid-State Electron.* 7, 525-529 (1964).

⁴ Swartzendruber, L. J., *Correction Factor Tables for Four-Point Probe Resistivity Measurements on Thin, Circular Semiconductor Samples*, Nat. Bur. Stand. (U.S.), Tech. Note 199 (Apr. 1964), available for 30 cents from the above source as SD Catalog No. C13.46:199; and Swartzendruber, L. J., *Four-point probe measurement of non-uniformities in semiconductor sheet resistivity*, *Solid-State Electron.* 7, 413-422 (1964).

⁵ Bullis, W. M., Brewer, F. H., Kolstad, C. D., and Swartzendruber, L. J., *Temperature coefficient of resistivity of silicon and germanium near room temperature*, *Solid-State Electron.* 11, 629-646 (1968).

⁶ Swartzendruber, L. J., Ulmer, F. H., and Coleman, J. A., *Direct reading instrument for silicon and germanium four-probe resistivity measurements*, *Rev. Sci. Instr.* 39, 1858-1863 (1968).

NOTE: Further information on research in semiconductor technology can be found in the series of quarterly reports edited by W. Murray Bullis and published as NBS Tech. Notes entitled *Methods of Measurement for Semiconductor Materials, Process Control, and Devices*. They are available from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402. To date the issues, periods covered, prices, and Superintendent of Documents Catalog Numbers are:

TN 472, July 1 to Sept. 30, 1968, 50 cents, C13.46:472
TN 475, Oct. 1 to Dec. 31, 1968, 45 cents, C13.46:475
TN 488, Jan. 1 to March 31, 1969, 50 cents, C13.46:488
TN 495, April 1 to June 30, 1969, 50 cents, C13.46:495
TN 520, July 1 to Sept. 30, 1969, 65 cents, C13.46:520
TN 527, Oct. 1 to Dec. 31, 1969, 60 cents, C13.46:527

SEPARATION OF POLYMER MOLECULES BY FLOW

SCIENTISTS at the Bureau have proposed a method for separating polymer molecules of different sizes on the basis of flow alone.^{1,2} Formulated by E. A. DiMarzio and C. M. Guttman of the NBS Institute for Materials Research, the concept of separation by flow is this: An isolated polymer molecule undergoing Brownian motion and flowing in a fluid through a capillary will have an average velocity greater than that of the fluid. This results because the center of the molecule (assumed to be a rigid sphere) cannot get any closer to the walls of the capillary than its radius (figure 1). It therefore samples only those fluid velocities away from the walls. Because the fluid velocity is larger the farther the distance from the walls, larger molecules will have higher average velocities than smaller molecules and will emerge first.

To illustrate, particles of two different sizes are placed at the top of a tube. As they flow through the tube, the average distance between them increases linearly with time because of the difference in their average velocities. From this study it was shown that because the particles obey a modified diffusion equation, the peak widths of the distribution of particle distances about the mean value for each kind of particle increases with the square root of time. It therefore follows that after a period of time the separation between peaks can be made large compared to the width of

the peaks with the result that the molecules separate into distinct groups. The Bureau scientists placed this theory on a quantitative basis by deriving formulae for the velocity of a polymer molecule as a function of its size, of its position in the tube, and of the geometry of the tube.

Drs. DiMarzio and Guttman also suggest the separation by flow phenomenon as an explanation of gel permeation chromatography (and gel filtration) on the basis of three points.³ First, they show that the dependence of elution volume on hydrodynamic volume alone exists in both

systems. They also show that for both, the variance in elution volume has the same qualitative dependence on the diffusion coefficient and the flow rate. And lastly, they propose a separation by flow model, whose elution volume behavior turns out to be identical in all its essential features to that of a gel permeation chromatography column.

Although the separation by flow theory was developed for polymer molecules, its concepts should be applicable to other particles as well, such as viruses or colloidal paint particles. The only major restriction to other possibilities would seem to be that the particles must move across the diameter of the tube several times during their traverse through the tube and thus sample the different fluid velocities.

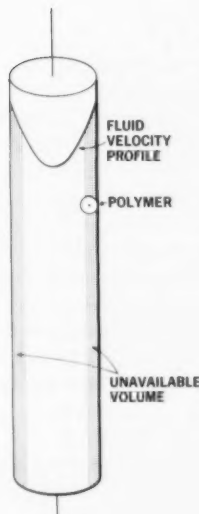
Whether the separation by flow phenomenon will be of practical use will depend on the construction of a working instrument. Using the theory of Drs. DiMarzio and Guttman, several designs for separation instruments have been proposed by Woo Taik Moon, a summer employee at NBS. Of these, the designs based on membrane filters appear to offer the best possibility for an acceptable device at the present time because of engineering ability to produce filters with sufficiently small diameter holes. The separation theory is likewise applicable to membrane filters when it is remembered that a membrane riddled with holes is analogous to a bank of parallel capillary tubes. In many of the other designs, the factor limiting their acceptance is the state of the machinist's or glass blower's art; submicron diameter holes and tube openings are unattainable. However, if these dimensions could be achieved, devices of various configurations could be fabricated.

For further details, see:

¹ DiMarzio, E. A., and Guttman, C. M., *Separation by flow*, *Poly. Letters* 7, 267 (1969).

² DiMarzio, E. A., and Guttman, C. M., *Separation by flow*, *Macromol.* 3, No. 2, 131-146 (Mar.-Apr. 1970).

³ Guttman, C. M., and DiMarzio, E. A., *Separation by flow*, II. Application to gel permeation chromatography, to be published.



MEASUREMENT ANALYSIS PROGRAM IN MASS

Slowly, and with a great deal of effort, a new dimension has been added to the Bureau's approach to calibration.^{1, 2} Originally named the Pilot Program, in recognition of the experimental nature of the program when initiated, the new approach involves a change in attitude toward calibration and provides participating laboratories with procedures to give them continuing knowledge concerning their measurement processes. The initial application to mass was so successful that the concept has now been broadened to include other measurement areas and has been renamed the Measurement Analysis Program (MAP). MAP is largely the product of cooperation between Paul Pontius and Joseph Cameron, with considerable support from Robert Raybold. The concepts of MAP are widely applicable, and the possibility of using this approach in standard cell and gage block calibration is being investigated.

What did mass calibration, in the traditional sense, mean to a laboratory? Practically, very little. A laboratory would send NBS a set of weights, and for each weight NBS would determine a difference between the stated and actual mass. Returned to the user, this set would usually be regarded as a "master set" used only on special occasions, and returned to NBS periodically for calibration. This procedure really furnishes only one piece of information—the mass of each weight at the time it was calibrated at NBS. It tells nothing about possible changes in the weights between calibrations, nor, more importantly, anything about the measurement system in which the weights were being used. This does not mean that accurate mass measurements were not being made in pre-MAP days. Many excellent measurements were made, but the statistical data upon which to base real confidence were generally lacking.

The essence of MAP is that a laboratory can establish and monitor the performance of its mass measurement process through a relatively simple procedure. This is done by making repeated measurements on the same object, a weight called the check standard. When a laboratory accumulates many values for the check standard, a plot can be drawn showing the values determined as a function of time (figure 1). As many values accumulate, and average value for the check standard can be established. As the data collection grows, limits can be established within which an expected percentage of all measurements made on the check standard can be expected to fall (figure 2).

Once enough values have been collected to be representative of the various conditions under which the process can be expected to operate, a check at any time can be made on the process by calibrating the check standard. If its value falls within established

Figure 1.

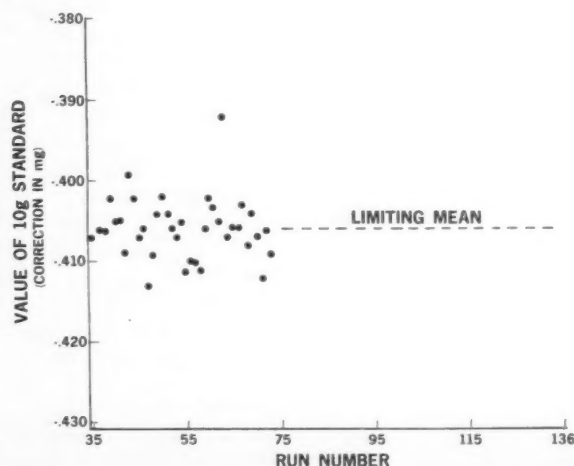
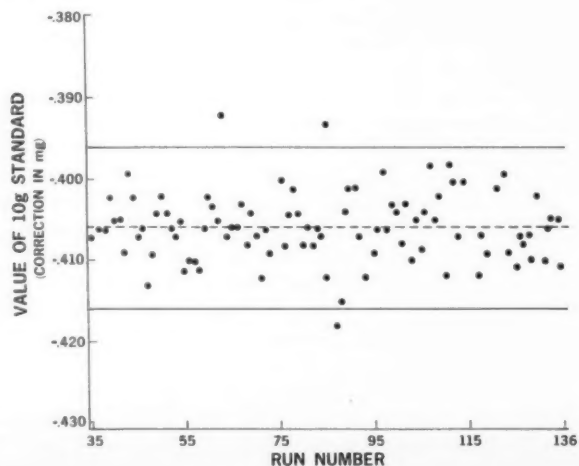


Figure 2.



limits, and the precision of the day's operation is also within prescribed limits, the process is operating in statistical control. If the value for the check standard falls outside the established limits, either an inexplicable error has been made, or something has happened to the standard. If subsequent values for the check standard cluster around the previous average, the out-of-bounds measurement is regarded as being a random event, and the process is back in control. If, even after cleaning the standards, measurements cluster around a new average value, a permanent change in the standard can be assumed.

To summarize: a series of calibrations of the same weight under the variable conditions of actual usage establishes the performance to be expected of the measurement process. Continued recalibration of that weight, as part of the routine calibration of other weights, provides a reliable indication of whether or not the process is performing as expected. The demonstrated ability to assign a value to one's own check standard gives confidence that the values assigned to the test weights are also reliable.



STANDARD FREQUENCY AND TIME BROADCASTS

High-frequency radio stations WWV (Fort Collins, Colo.) and WWVH (Maui, Hawaii) broadcast time signals on the Coordinated Universal Time (UTC) system as coordinated by the Bureau International de l'Heure (BIH), Paris, France. The NBS time scale, UTC(NBS) and the U.S. Naval Observatory time scale, UTC(USNO) are jointly coordinated to within ± 5 microseconds. The UTC pulses occur at intervals that are

MAP had its inception when statistical analyses were made of data on NBS standards dating back many years. From this study came the realization that any laboratory could, by generating data of a similar type, but perhaps on a lesser scale, establish the performance of its own mass measurement process.

To extend MAP concepts, NBS radically changed its relationship with outside mass calibration laboratories. (Although some traditional mass calibration is still done for laboratories having sufficient need, a considerable effort in the mass lab is directed to MAP.) A calibration laboratory wishing to participate in the Program progresses through a series of steps. First, if necessary, the laboratory personnel are trained, the equipment is tested, and lines of communication are established. Next, starting standards, usually two one-kilogram weights, are furnished by the lab and calibrated at NBS. Then, using the kilograms as a point of departure, the laboratory repeatedly calibrates a set of weights, providing the starting data for statistical evaluation. Once sufficient data are on hand, estimates of process per-

formance are established and the lab uses MAP as necessary in its operation. With knowledge of the performance of its measurement process and of the uncertainty of its standards, a laboratory is in a position to make meaningful, demonstrable statements concerning the uncertainty of its measurements.

At present sixteen laboratories around the country are active participants in the mass MAP, each now fully aware of the capabilities of its own process and collectively forming a network having a common basis for mass determination. The network has been tested by having all of the participants calibrate pairs of kilograms. Test data analysis indicated all participants were in a state of control and the range of values assigned to the test objects did not exceed a part in one million.

For further information see:

¹ Pontius, P. E., *Measurement Philosophy of the Pilot Program for Mass Calibration*, NBS Tech. Note 288, available from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402. Order by SD Catalog No. C13.46:288 (30 cents).

² Pontius, P. E., and Cameron, J., *Realistic Uncertainties and the Mass Measurement Process*, NBS Mono. 103, SD Catalog No. C13.44:103 (20 cents).

STANDARDS AND CALIBRATION

longer than one coordinate second by 300 parts in 10^{10} during 1970, due to an offset in carrier frequency coordinated by BIH. To maintain the UTC scales in close agreement with the astronomers' time, UT2, phase adjustments are made at 0000 hours Greenwich Mean Time (GMT) on the first day of a month as announced by BIH. *There will be no adjustment made on October 1, 1970.*

The low-frequency radio station WWVB (Fort Collins, Colo.) broadcasts second pulses without offset to make available to users the standard of frequency so that absolute frequency

comparisons may be made directly, following the Stepped Atomic Time (SAT) system. Step time adjustments of 200 ms are made at 0000 hours GMT on the first day of a month when necessary. BIH announces when such adjustments should be made in the scale to maintain the seconds pulses within about 100 ms of UT2. *There will be no adjustment made on October 1, 1970.*

NBS obtains daily UT2 information from forecasts of extrapolated UT2 clock readings provided by the U.S. Naval Observatory with whom NBS maintains close cooperation.

HAZARDOUS NOISE LEVELS IN COMPUTER LABS

RELATIVELY SIMPLE ERRORS BY PROGRAMMERS have been blamed on high noise levels in computer laboratories. This has brought about an investigation¹ of the noise levels in a typical computer lab by E. L. Corliss and R. D. Berendt of the NBS Institute for Basic Standards. They found that not only is the noise disruptive to concentration and communication, but in some cases the level is sufficiently high to cause permanent hearing damage.

The computer is a lineal descendant of two of the most serious industrial noisemakers of the nineteenth century; weaving mills and print shops. In many computer labs it is difficult, if not impossible, to carry on any conversation over a distance of six feet, which is a rough indication of hazardous instead of merely annoying conditions. This noise level implies about 80 dB and exists in some labs when the computer is in its quiescent condition (no reading, printing, or punching). With the equipment working, sound meter measurements in a typical lab showed long-term RMS noise levels ranging from 89 to 94 dB, depending upon the particular operation taking place. The overall level at the counter where customers waited for their printouts was about 5 dB less. However, the peaks that were smoothed out by the meter are estimated to add 6 dB to the observed long-term level.

These noise levels mean that persons in the room have their hearing at risk. It has been proposed upon the basis of medical histories of noise-induced hearing loss that a significant risk of damage to hearing exists if a

half day's exposure to levels in excess of 90 dB occurs with any regularity. Exposure for a full working day should not exceed a level of 85 dB.^{2,3} Further, it has been proposed that the criterion level be lowered by another 5 dB if the sound sources are narrowly sinusoidal, as the printer and punch prove to be.

In one computer lab, acoustic treatment by providing a substantial coating of acoustic tile on the ceiling and upper parts of the walls did little toward solving the problem. Fortunately, there are other straightforward techniques that can be applied to reduce the noise hazard.

First, personnel working in the lab should have their hearing measured at frequent intervals, and wear ear protection until the conditions where they work permit carrying out a conversation at a reasonable speaking distance without shouting. Second, they should not stay in the vicinity of the noisy equipment unless their presence is required.

In the computer laboratory itself, a significant reduction of the noise could be achieved by adopting the following recommendations in the order listed. This order is chosen on the basis that the major noise source must be attenuated before reduction of the noise from subsidiary sources will have any significant effect.

1. Cover all ports or openings around card punches, readers, and printers with 1/4 in clear lucite shields edged with soft rubber gaskets to effect an airtight seal.

2. Wherever possible, vibration mount all drive motors, cooling fans,

etc., on rubber pads or use rubber sleeves (grommet type) on mounting bolts.

3. All console panels should be treated with viscoelastic type vibration damping material.

4. Install 3/4 in fiberglass board liners on the inside surfaces of console paneling to reduce the noise buildup in the hollow reverberant cavities.

5. Install acoustically lined ducts at the intake and discharge sides of cooling fans, if fans are mounted near or on console panels.

6. Install resilient pads or vibration isolators under all equipment to reduce low frequency vibratory transmission to the supporting false floor.

7. Install acoustically-lined partial enclosures (U shaped) around individual computers.

8. If a choice is available, give preference to multibladed slow speed fans and wide ducts in providing for the cooling of equipment.

9. If the above measures cannot be adopted, locate all computers and associated equipment in a separate room, away from office personnel. Operating personnel exposed to the near noise field of the equipment should wear ear protectors.

For further information, see:

¹ Corliss, E. L., and Berendt, R. D., Computers—A white-collar industrial hazard, IEEE Trans. of professional group on Audio Engineering (to be published).

² Ward, W. D., Proposed damage-risk criteria for intermittent noise exposure, Proc. XV Internationaler Kongress für Arbeitsmedizin, Paper AIV-36, pp. 143-149 (Sept. 1966).

³ Noise Exposure Provisions of the Walsh-Healey Act, Federal Register, 34, No. 96, Part II (May 20, 1969).

NBS MEASUREMENT SEMINARS 1971 SERIES

Seminars and workshops on the topics listed below have been announced for the 1971 series of NBS Measurement Seminars. These are scheduled to be given either at the NBS laboratories in Gaithersburg, Md., indicated by (G), or in Boulder, Colo., indicated by (B). The announced topics and dates are as follows:

Laser Power and Energy Measurements (B)....	Jan. 14-15, 1971
High-Frequency and Microwave Impedance (B).....	Mar. 16-19, 1971
Low Frequency Electrical Standards (G)....	Apr. 26-28, 1971
Colorimetry and Spectrophotometry (G)....	May 3-5, 1971

The seminars and workshops are one of several NBS activities that provide advice and assistance on measurement and calibration problems to the

growing number of standards laboratories in tracing to NBS standards the accuracies of measurement needed for research work, factory production, or field evaluation. Participation is open to a limited number of persons from measurement and standards laboratories who meet appropriate prerequisites relating to education, work experience, and current professional activity.

Each seminar lasts from two to four days and its meetings are devoted to lectures, group discussions, and laboratory demonstrations. A course may be cancelled if registration is insufficient. However, in the past, requests for enrollment have nearly always exceeded the numbers that could be accommodated. Laboratory directors who wish to have members of their staff attend any of these courses are therefore urged to send, as soon as possible, a letter of application to the individual named in the course descrip-

tions below. Letters should include details of the candidate's qualifications in terms of the stated prerequisites. The form at the end of this description may be used for this purpose. Applications should also be accompanied by a check, billing authorization, or purchase order for the stated fee.

Acceptance of qualified applicants, on the basis of first come first served, other things being equal, will be made by letter not later than four weeks prior to the scheduled date of the course. Detailed information on schedules and housing will be available at that time. Those accepted will be expected to study the assigned reading material before coming to the course and should be prepared to discuss their own experiences with related problems.

LASER POWER AND ENERGY MEASUREMENTS (B)

Description: The 2-day seminar will discuss the techniques used by NBS to measure the power and energy output of lasers. The wavelength range will be 488.0 nm to 10.6 μm ; cw power will range up to 200 W and pulse energy up to 100 J. Measurement of average power and peak power of high rep-rate lasers will also be discussed. Topics discussed will include calorimeters, detectors of various types, beam sampling methods, and error analysis.

Prerequisites: Candidates must have college-level training in engineering or physics, or equivalent experience, and must be currently engaged in precision measurements at a professional level.

Arrangements: Attendance will be limited to approximately 40. Fee: \$100 (includes refreshment snacks to be served during coffee-breaks). Dates: January 14-15, 1971. Apply to: Administrative Officer, NBS Radio Standards Physics Division, Boulder, Colo. 80302 (Tel: 303-447-3671).

HIGH FREQUENCY AND MICROWAVE IMPEDANCE (B)

Description: A 4-day seminar on impedance measurement including theory, technique, instrumentation, standards and error analysis. Lecture periods will be followed by laboratory demonstrations with opportunities for consideration and discussion of specific problems. Subject matter will cover a frequency range extending from 30 kHz to 40 GHz. Topics will include the following. Lumped Parameter: Evaluation and use of adaptors; Coaxial capacitor calibration; Range extension techniques; Modular instruments. Distributed Parameter (including coax and hollow wave guide): Slotted lines; Quarter and half wave techniques; Node shift and Winzimer methods; Coaxial reflectometer. Other subjects: Coax connectors; Swept frequency measurements; Time domain reflectometry; Automated measurements.

Prerequisites: Candidates must have college undergraduate training in engineering or physics or equivalent experience and should be currently engaged in making precision measurements.

Arrangements: Attendance will be limited to 30 persons. Fee: \$300. Tentative Dates: March 16, 17, 18, 19, 1971. Apply to: R. E. Nelson, 272.04, H. F. Circuit Standards Section, National Bureau of Standards, Boulder, Colo. 80302 (Tel: 303-447-1000).

LOW FREQUENCY ELECTRICAL STANDARDS (G)

Description: The 3-day seminar will present information on the accurate measurement of electrical quantities and the calibration of electrical standards. It will cover the measurement methods used by the Bureau to establish and maintain the basic electrical units and to calibrate customers' standards of resistance, voltage, current, capacitance,

inductance, and power from direct current up through 30 kHz. Voltage and current-ratio measurements will be included. The program will consist of lectures and demonstrations in the Electricity Division laboratories. Emphasis will be on measurement techniques which should be useful to workers in standards and calibration laboratories.

Prerequisites: Candidates must have undergraduate college-level training in physics or electrical engineering and must be currently engaged in professional work in precise electrical measure-

ments at a level involving the basic reference standards of a calibration or standards laboratory. Preference will be given to those whose position involves the training of others in precise electrical measurements.

Arrangements: Attendance will be limited to 50 persons and, for laboratory demonstrations, each group will be divided into subgroups. Fee: \$140. Dates: April 26, 27, 28, 1971. Apply to: R. F. Dziuba, Electricity Division, National Bureau of Standards, Washington, D.C. 20234 (Tel: 301-921-2727).

APPLICATION FOR REGISTRATION NBS MEASUREMENT SEMINARS

Title and date of seminar:

Date of application:

Applicant's name and address:

Company or agency affiliation:

Title of position in company or agency:

College level training:

Supervisory or laboratory experience related to measurement:

Citizenship:

Reprints of the material to be reviewed prior to the seminar will be mailed upon acceptance of this application.

Make registration fee payable to: National Bureau of Standards.

COLORIMETRY AND SPECTROPHOTOMETRY (G)

Description: A 3-day seminar that deals with color measurement in its psychological and physical aspects. Subjects to be treated are: The psychophysics of color vision, uniform color space, color-order systems, spectrophotometry, photodetector response, photoelectric colorimeters, automation of colorimetry, metamerism, variability of color measurement. The seminar will consist of lectures, discussions, and visits to NBS colorimetry and spectrophotometry laboratories.

Prerequisites: Candidates must have college-level training in physics, chemistry, engineering, or psychology, and be involved in experimental colorimetry or spectrophotometry, either in a direct or supervisory capacity. Prior to the seminar, candidates will be furnished with a list of references and copies of selected articles.

Arrangements: Group will be limited to 50, selected on the basis of academic qualifications and experience. Fee: \$150. Dates: May 3, 4, 5, 1971. Apply to: I. Nimeroff, NBS Office of Colorimetry, Washington, D.C. 20234 (Tel: 301-921-3515).



U.S. DEPARTMENT OF COMMERCE
National Bureau of Standards

NEW FORMAT FOR CAST SERVICE

Effective July 10, the present Clearinghouse Announcements in Science and Technology (CAST) system of 46 categories was replaced by a new grouping consisting of 35 categories (numbered sequentially from 51 through 85) and 350 sub-categories. Thus, the person subscribing to Category 66, Electrotechnology, and primarily interested in reports on Optoelectronic Devices will be able to locate quickly the reports in this narrow field.

CAST is a current awareness announcement service tailored to the needs of the busy executive, scientist, engineer, businessman, and project manager. Its new format permits the user to browse through bibliographic information about new reports in his broad technological field of interest, or to quickly scan a specific subject within the field.

Documents announced for sale in CAST are not limited to the scientific and technical fields. An increasing percentage is concerned with the social sciences, commerce, business, and industry. Their subjects range from poverty to banking and finance; from environmental pollution to area development; from transportation safety to new products and materials.

Each entry contains a complete bibliographic citation including document title, corporate source, personal authors, report date, page count, and supplementary notes. Also included are an abstract (or referral to the publication containing an abstract), the stock (accession) number, and document price. Reports considered

to be of special interest to the public or to have potential applications for business and industry are flagged.

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The annual subscription price per category is \$5 (\$6.25 foreign) with a maximum cost of \$125 (\$156.25 foreign) for all categories.

To subscribe, give the number and title of the category, and enclose check or money order payable to the Clearinghouse. If you maintain a Clearinghouse deposit account, cite the account number. Mail to: Clearinghouse (152.12), U.S. Department of Commerce, Springfield, Va. 22151.

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51. Aeronautics and Aerodynamics
52. Agriculture and Food
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56. Behavioral and Social Sciences
57. Biological and Medical Sciences
58. Biotechnology and Medical Engineering
59. Chemistry

60. Civil, Structural and Marine Engineering
61. Communication Systems
62. Computers, Control Theory, Information Theory
63. Detection and Countermeasures
64. Earth Sciences
65. Economics, Business and Commerce
66. Electrotechnology
67. Energy Conversion (Non-Propulsive)
68. Environmental Pollution and Control
69. Industrial and Mechanical Engineering
70. Managerial and Information Sciences
71. Materials Sciences
72. Mathematical Sciences
73. Methods, Instrumentation and Equipment
74. Military Sciences
75. Missile Technology
76. Navigation, Guidance and Control
77. Nuclear Science and Technology
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79. Ordnance
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COLOR TEMPERATURE, LUMINOUS EFFICACY AND THE INTERNATIONAL PRACTICAL TEMPERATURE SCALE OF 1968

THE INTERNATIONAL PRACTICAL TEMPERATURE SCALE OF 1968¹ (IPTS₆₈) differs from the International Practical Temperature Scale of 1948 by assigning a higher value (1337.58 K) to the temperature of freezing gold and a higher value (0.014 388 m-K) to c_2 , the second constant in the Planck radiation formula. Consequential changes of importance to the colorimetrist and the photometrist have been outlined by Dr. D. B. Judd and D. McSparron of NBS.

The international temperature scales of 1927, 1948, and now 1968 form the basis of the NBS color temperature scales of 1934,² 1949,³ and 1970 (as of July 1, 1970) respectively. Color temperature, defined as "The absolute temperature at which a blackbody radiator must be operated to have a chromaticity equal to that of the light source,"⁴ is used by the colorimetrist to specify light-source chromaticities not too different from those of the blackbody radiator, such as incandescent lamps, phases of natural daylight, and fluorescent lamps. Color temperature is also used by him to define the relative spectral distribution of sources, such as incandescent lamps, that are spectrally similar to the blackbody radiator, and by the

photometrist-radiometrist to infer the spectral radiant power of such sources.* IPTS₆₈ differs in its consequences for these two different uses.

The photometrist-radiometrist is sometimes interested in obtaining the current best inference of the spectral radiant power in the visible region from his incandescent lamp standard of luminous intensity (or flux) calibrated to operate at a specified color temperature.⁵ To do this he must first

Table 1

Color Temperature on 1949 Color Temp. Scale	Kelvins to Add to Convert to 1970 Scale ($T_{68} - T_{48}$)	Color Temperature on 1970 Color Temp. Scale
1600 K	1.9	1601.9 K
1800	2.2	1802.2
2000	2.7	2002.7
2200	3.1	2203.1
2400	3.6	2403.6
2600	4.0	2604.0
2800	4.6	2804.6
3000	5.1	3005.1
3200	5.7	3205.7
3400	6.3	3406.3

*For these sources, color temperature has values no different from those of distribution temperature, recently defined as the absolute temperature of a full radiator for which the ordinates of the spectral distribution curve of emission are proportional (or approximately so), in the visible region, to those of the distribution curve of the radiation considered.

determine, either by a new calibration or by adjustment of the IPTS₄₈ calibration, the color temperature on IPTS₆₈. The color temperature can be found by using Table 1, which, calculated from the formula given by Kostkowski,⁶ gives the changes from IPTS₄₈ for the range of color temperatures usually encountered with incandescent sources.

The changes in IPTS₆₈ imply a change in the value of K_m , the maximum luminous efficacy of radiation. The change in the assigned value of the gold point and in the value of c_2 imply a change from 2042 K to 2045 K in the value assigned to the freezing point of platinum. In the region above the gold point values of spectral radiant exitance computed from the Planck formula,

$$M_e = c_1 \lambda^{-5} (e^{c_2/\lambda T} - 1)^{-1}$$

are all raised because, for any given fixed physical phenomenon (e.g., the freezing of platinum), the ratio c_2/T is lowered. The definition of the candela remains unchanged at 60 candelas per cm² from a blackbody at the freezing point of platinum. Hence, since the radiance of this blackbody had been raised, the ratio of lumens to watts has been lowered by these

changes in IPTS₆₈. Table 2 gives the results of these changes.

Table 2

Maximum Luminous Efficacy, K_m	1948	1968
K_m (photopic).	680 lumens per watt.	673 lumens per watt.
K_m' (scotopic).	1747 scotopic lumens per watt.	1725 scotopic lumens per watt.

Inference of the spectral radiant power in the visible region of a given source made as described by Barbrow⁵ should be based on the new values of c_2 , T and K_m . Preston⁷ gives a discussion of how blackbody tables based on IPTS₄₈ may be used to give values on IPTS₆₈. Note that all tables based on IPTS₄₈, such as those given by Barbrow,⁵ must be revised to give values on the new scale.

On the other hand, through the course of changing temperature scales over the years, the colorimetrist has adopted the policy of holding certain relative spectral distributions (for example, CIE sources A, B, and C) invariant. He has merely shifted the color temperature labels by which he designates these reference sources. Since it is the c_2/T ratio that sets the spectral distribution by the Planck radiation formula, the colorimetrist will wish to hold this ratio constant in computing his new temperature designations as follows:

Table 3

Temperature on 1948 Scale T_{48}	14 388 T_{48} 14 380	Kelvins to add to T_{48} to obtain temperatures on T_{68} both of the same Implied Spectral Distributions.
1600 K	1600.9 K	0.9
1800	1801.0	1.0
2000	2001.1	1.1
2200	2201.2	1.2
2400	2401.3	1.3
2600	2601.4	1.4
2800	2801.6	1.6
3000	3001.7	1.7
3200	3201.8	1.8
3400	3401.9	1.9

Table 4

	1968 Temperature Scale Compared to 1948 Scale		T_{1968} implying the same spectral distribution as T_{1948}
	T_{1948}	T_{1968}	
Second constant, c_2 of			
Planck formula.....	0.014 380 m-K	0.014 388 m-K	
Freezing point of gold.....	1336.15 K	1337.58 K	1336.89 K
K_m (Maximum luminous efficacy of photopic radiation).....	680 lumens/watt	673 lumens/watt	
Freezing point of platinum....	2042 K	2045 K	2043
Vacuum tungsten lamp.....	2365	2369	2366
Gas-filled tungsten lamp (CIE illuminant A).....	2854	2859	2856
Lamp for calibrating photocell output.....	2870	2875	2872
Noon sunlight (CIE illuminant B).....	4870	4882	4873
Average daylight (CIE illuminant C).....	6770	6791	6774

nations as follows:

$$T_{68} = \frac{c_2 (1968) T_{48}}{c_2 (1948)} = \frac{0.014 388 T_{48}}{0.014 380}$$

Table 3 gives the temperatures on IPTS₆₈ necessary to preserve the spectral distributions of IPTS₄₈.

Beginning on July 1, 1970, all color temperatures quoted by NBS will be on IPTS₆₈. The user of incandescent lamp standards of intensity or flux based on the 1948 scale must choose carefully among the various courses of action open to him. One option is to order a new standard. Or, since all of the changes are relatively small, the user may decide instead to adjust his existing standards. Before doing this, he must carefully decide whether his usage is photometric-radiometric or colorimetric, that is, whether he wishes to describe as accurately as possible his present standards or to maintain a defined spectral distribution. If his usage is strictly photometric-radiometric, he may obtain the new value of color temperature by the use of Table 1. If his usage is colorimetric, an adjustment to the operating characteristics of the standard (voltage and current) will be necessary. To determine the amount of adjustment necessary, one must determine from Table 1 the temperature on IPTS₆₈ at which his standard has been operating and from Table 3 the temperature at

which he would like it to operate. The difference between these two figures gives the amount of adjustment necessary. Judd⁸ gives methods for computing the change necessary in operating parameters for the particular lamp. If such a change in operating parameters is made to an existing standard of luminous intensity (or flux) a further adjustment of the assigned values of intensity (or flux) will also have to be made.⁹

Table 4 summarizes the various differences between IPTS₄₈ and IPTS₆₈.

¹ Comptes rendus de la treizieme Conference Generale des Poids et Mesures, 1967-1968, Annexe 2, and Comite Consultative de Thermometrie, 8^e session, 1968, Annexe 18.

² Wensel, H. T., Judd, D. B., and Roeser, W. F., Establishment of a Scale of Color Temperature, BS J. Res. 12, 572 (1934), RP 677.

³ Judd, D. B., The 1949 Scale of Color Temperature, J. Res. NBS, 44, 1 (1950), RP 2053.

⁴ USA Standard Nomenclature and Definitions for Illuminating Engineering, Z 7.1-1967.

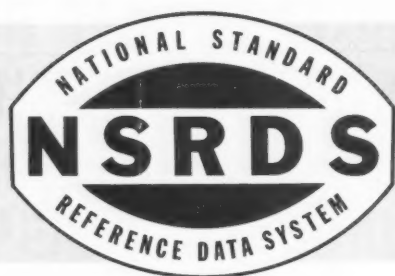
⁵ Barbrow, L. E., Memorandum on a Procedure for Obtaining Spectral Radiant Intensities of Tungsten Filament Lamps, 400-700 $m\mu$, J. Opt. Soc. Am., 49, 1122 (1959).

⁶ Kostkowski, H. J., Lack of Uniqueness in the International Practical Temperature Scale above the Gold Point, Metrologia 3, No. 1, 28-29 (Jan. 1967).

⁷ Preston, J. S., Introduction of the Practical Temperature Scale 1968: Some Effects in Relation to Light Sources, Color Temperature, and Colorimetry, Lighting Research and Technology 1, No. 4 (1969).

⁸ Judd, op. cit.

⁹ Barbrow, L. E., and Meyer, J. F., Characteristic Equations of Vacuum and Gas-Filled Tungsten Filament Lamps, BS J. Res. 9, 721 (1932), RP 502.



NEWS

The NSRDS was established to make critically evaluated data in the physical sciences available to science and technology on a national basis. The NSRDS is administered and coordinated by the NBS Office of Standard Reference Data.

CRITICAL DATA IN THE PHYSICAL SCIENCES

In a paper presented to the Council of Biology Editors, Carleton University, Ottawa, Canada, May 11, 1970, David Garvin, Chief of the NBS Chemical Kinetics Information Center discussed critical data in the physical sciences. Because the talk focused attention on problems facing data evaluators, the following excerpts of the talk are presented.

Critical data is a broad topic, and only a few aspects—those of current interest—can be covered. The topic also is diffuse and is difficult to define. The term "critical data" is a technical term and is misleading. What we are concerned with is "reliable data," that is, data that may be used with confidence in planning experiments, reducing results and interpreting phenomena. The term "critical data" is used in the sense of criticism: review, selection, comparison, and recommendation. This is part of the process of providing a discipline with a large body of information, in readily accessible form, upon which that discipline must build.

The hoped-for results of this criticism are reliable data—results that

stand not the test of time, but the tests of repeated measurement and consistency with related research. This implies retrospective examination, analysis, correlation, and an attempt to synthesize the best available quantitative statement about the phenomenon under study. This is evaluation.

Evaluation is a task that is expected of each author—he is to place his new results in the context of previous measurements. Many do this, often successfully. But the man who discusses his own work, and who must heed the stricture that only novel results are publishable, is rarely a disinterested party. Hence the emergence of the evaluator, the scientist who devotes all or part of his effort to a regularization of scientific measurements. . . .

In the past, numerical data about physical properties and about processes usually have been distributed to the general scientific user by means of handbooks. This procedure continues today. . . .

In the better compilations and evaluations the sources of the data are given. Omission of this information is, in my opinion, inexcusable. There are more subtle omissions. Frequently, no indication exists of the basis used by the compiler or evaluator in selecting or synthesizing the numerical data. Nor is one likely to find a good indication of what material was examined in the course of making the choices. To ask for the inclusion of these missing items is to ask for a great amount of work. Pre-

paring a running commentary for tables is far from easy. If this is done, the book can easily double in size. These limitations notwithstanding, the handbook is an excellent medium, the information density is high. It is organized in a consistent manner and, above all, can be kept available for ready reference where it is needed.

Our concern with the handbook must be to keep its quality high: to see that the best available data are used in its tables, and that it is up-to-date.

If only *one* handbook existed, the user of numerical data would have an easy task. But, many exist, as do many, often unsuspected, sources of "best values." Data are distributed to the user via the normal publication process: The user must hunt for the source, and then assess its reliability. He deserves two aids: a strong advertising campaign on the part of the publisher and a continuing program of book reviews. Editors of journals can help with the latter.

Books of tables are difficult to review but they deserve the effort. Because many users are not experts in the subjects reviewed and because they will reply upon the tabulations for input to their own experiments, a very important need exists for disinterested, detailed discussions of the strong and weak points of these books.

The future will bring a change in the distribution technique. This will be the data bank maintained by an information center. With luck, the

user will be able to query this central storehouse directly and from a remote location. With even greater luck, he will get in reply the best, most up-to-date value.

This picture of the future adds nothing but ease of operation. Asking a question of a data bank is simply having a machine open the handbook to the proper page. It does not improve the data. The evaluator must do that.

To some extent this future mode of operation now exists. There are specialized, remotely available data systems. But more important, there are information centers. Most of them will reply to requests for information. The postal system is an effective, inexpensive mechanism for connecting the user with the source of the desired data. . . .

The Art of Evaluation

There is a basic distinction between the activities of the experimentalist and the evaluator. The former attempts to get a new datum by measuring a natural phenomenon. The latter examines and compares all the available measurements, with the goal of establishing the most reliable value. The theorist may use a similar examination in the course of testing or developing a concept.

Beyond this, a formal statement of the procedures followed by an evaluator or an experimentalist is not useful. Both pursue their goals by means not well understood even by those skilled in the art.

However, an analogy may help explain the scholarly activity of evaluation. It is similar to the examination of eyewitness accounts of an event. First the evaluator must determine that the witnesses are describing the same event. Then he needs to find what is common and what is conflicting in their accounts. Finally an attempt must be made to develop a consistent (and possible) statement of what occurred. So far, so good. But at all times he must keep in mind the possibility that a new witness, perhaps armed with a well focused cam-

era, may report in. The evaluator is always out on a limb.

Who is this man, the intrepid evaluator? He is not a bibliographer, a librarian, a computer programmer, or an administrator, although he may be forced to learn to be all of these. He is an expert in his subject field.

That expertise is essential. The research area for which he may be called an expert should not be too narrow. He will need to examine and select collateral information. For example, equilibrium data are often used in chemical kinetics.

Experimentalists who understand precision measurement and techniques are good candidates. So are theoreticians with a skeptical turn of mind. A flair for analysis and for the correlation of physical properties with molecular structure and reactivity is very useful.

His environment also is important. He needs to work in an active research environment. There are two reasons: (1) no man is a complete expert, and (2) the successful feedback from evaluation to experimentation is his most satisfying reward.

Improvement of the Published Paper: Aids to Retrieval

The primary resource upon which evaluation is based is the report of the results of research. This may be in a published paper, a report, or a letter. The first is the most important. All work worth saving should be published. And if it is worth publishing, it should be presented in good form. Here the editor and the evaluator can work together. I shall approach this topic from the viewpoint of the former, that is, how the editor can help. . . .

The editor's task is quality control. Two parts of it are: (1) control of the reporting of experimentation, and (2) control of the statement of the title and abstract.

The reliability of the published report is of major concern to the evaluator. The author must present sufficient information so that the technique used can be assessed and so that the data

presented can be reinterpreted and merged with other studies. Most "instructions to authors" ask for this. But they do not tell the author how to do it. Table 1 lists items needed in the exposition of an experimental method and includes nothing that is not encompassed by the instructions given to authors. It is, however, much more explicit.

Even this list is insufficient. It could be applied in general to any experimental work, but only by a person familiar with the particular class of experiments. I suggest that we need statements that are even more explicit.

Table 1: Items needed in the exposition of the experimental method

1. Description of apparatus with dimensions (either directly or by reference to earlier work).
2. Calibration of equipment, including a discussion of the magnitudes of possible systematic biases for which corrections were not made.
3. Experimental procedure.
4. Environmental conditions.
5. Identification of analytical methods used (and proof of them if novel).
6. Purity of materials and how determined.
7. Statement of sensitivity or resolution on all of the above.
8. Explanation of the method used to reduce the data.
9. Assumptions made in deriving the results.
10. Auxiliary data used including explicit statement of their values.
11. Numerical factors that relate the units used in reporting the data to the fundamental units of measure.
12. Reports on negative results.

These would form a large set of "standards for the reporting of data," each of which applies to a particular type of work. This is a deliberate attempt to reduce the detailed quality control work to comparison with a check list.

The standards would be used by editors and their primary agents, the referees, to check papers for proper content. I visualize a Manual for Referees, composed of these standards, that would be distributed with each paper sent out for review.

The preparation of these guidelines

is, clearly, a proper function for scientific societies. It can be done, it has been done. A number of guidelines exist for various types of chemical research, e.g., for gas chromatography, infrared spectra, calorimetry, and x-ray diffraction patterns. Therefore the utility of the suggestion can be tested by studying the effect of the existing recommendations. One important result of preparing these standards would be to alert research workers to important points that should be considered in the planning and execution of research.

A second quality control item concerns the presentation of numerical data. Careful specification of the experimental parameters is needed. Also the data should be as interpretation-free as possible. A basic test is that the data presented should show the experimental scatter. Experimental data points are more useful than smoothed values or averages. Without some indication of scatter, intercomparison of results in several papers becomes very difficult. For convenience the data should be tabulated and, if necessary, graphed. The final result recommended by the author should also be in a table, not buried in a discussion. Unless this is done the results will not be retrieved. Also he should estimate the reliability of his result, if he wants to publish it.

The third, and final, quality control topic is the statement of the abstract and title of the paper. This is the easiest one on which to make progress.

Two bland statements summarize the goals: (1) a title should be informative and specific, and (2) an abstract should summarize all types of material reported in the paper, particularly the types of properties measured.

Success in reaching these goals is becoming more important than it has been in the past. Abstract services appear to use the paper abstract almost verbatim. Abstracts and titles are the bases for current awareness services. Also, the machines that are invading the indexing field need good input if

they are to be of any help at all.

It is easy to improve titles and abstracts. Some examples drawn from chemical articles have been presented elsewhere.¹ But who can and should do this when the author does not? My answer is the editor. The following working rule is proposed:

The editor, on the advice of the referee, may, without recourse to the author, add factual material to an abstract.

Probably editors have this power. If so they should exercise it, and authors should be made aware of it. The referee, the first careful reader, is in a good position to make these improvements.

An expected result of this procedure will be that titles, abstracts and papers will be longer. This should be accepted. Perhaps the longer abstracts used for papers presented at meetings can serve as a guide. They tend to be informative.

This is a small price to pay for an improvement in the permanent content of scientific articles and in the ease with which the data may be retrieved from chaotic, random, and diffuse but well intentioned methods of communications.

ELECTROLYTIC CONDUCTANCE AND THE CONDUCTANCES OF THE HALOGEN ACIDS IN WATER

The most recent publication in the NSRDS series of critical data compilations is NSRDS-NBS-33, *Electrolytic Conductance and the Conductances of the Halogen Acids in Water*² (50 cents, SD Catalog No. C13.48:33), by Walter J. Hamer and Harold J. DeWane. The first such compilation since 1930, it brings together in one volume data scattered throughout the literature. An additional advantage of this compilation is a consistent expression of data. For example, most literature data are expressed on the old atomic weight scale of 16 for naturally occurring oxygen and in many cases the data are expressed in international ohms. All data reported in this document have been converted to absolute

ohms, and the ¹²C scale of atomic weights.

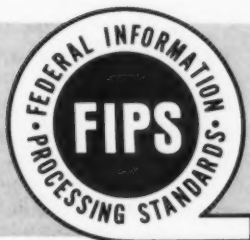
The present document gives definitions relating to the conductance of electrolytic solutions, general considerations of the migration of ions, and general laws governing the movement of ions under applied potential gradients. Conductance relations are then given, followed by a condensed treatment of the Debye-Hückel-Onsager-Fuoss theories of electrolytic conductance. Tables of data on the equivalent conductances of the halogen acids—hydrofluoric, hydrochloric, hydrobromic, and hydriodic—in water are given for a wide range of concentration and temperature. For the convenience of the reader, a glossary of symbols is provided at the end of the publication. Also included is a list of 66 references.

ROTATIONAL ENERGY LEVELS AND LINE INTENSITIES IN DIATOMIC MOLECULES

NBS Monograph 115, *The Calculation of Rotational Energy Levels and Rotational Line Intensities in Diatomic Molecules*² (55 cents, SD Catalog No. C13.44:115), by Jon T. Hougen, a work partially supported by the Office of Standard Reference Data, describes procedures for making quantum mechanical calculations of rotational energy levels and rotational line intensities in diatomic molecules. The procedures are illustrated by sample calculations. A familiarity with the material in this monograph should enable a practicing electronic spectroscopist to carry out his own theoretical calculations for molecules under experimental investigation. The monograph is aimed at the level of electronic spectroscopists who have had the equivalent of one semester of graduate quantum mechanics.

¹ Evans, W. H., and Garvin, D., *The Evaluator Versus the Chemical Literature*, J. Chem. Doc. (Aug. 1970).

² Available from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402, for the price indicated.



NOTES

In the fall of 1965 the Secretary of Commerce established the NBS Center for Computer Sciences and Technology to carry out the Secretary's responsibilities under the Brooks Bill (Public Law 89-306, passed October 30, 1965). The Center provides leadership and coordination for government efforts in the development of voluntary commercial information processing standards, develops recommendations for Federal information processing standards, performs required research and analysis, and provides scientific and technical support and consultative assistance in the field of computers and information processing to Federal agencies. These Notes will cover information-processing standards activities in the Federal Government, particularly those of the Center.

HIGHLIGHTS OF ISO STANDARDIZATION ACTIVITIES

Over 50 delegates from 13 countries and 5 liaison organizations attended the sixth meeting of the International Organization of Standardization Technical Committee ISO/TC 97, Computers and Information Processing, held in West Berlin, June 8-10, 1970.

The delegates adopted a number of resolutions concerning international work in information processing. Among which are the following:

- To initiate work to establish standards for magnetic tape cassettes. The task was assigned to Working Group 1, Magnetic Tape, of Subcommittee 4, Input/Output.

- To forward the First Draft ISO Proposal on Abbreviations for Names

of Units (SI Units) to be Used in Systems with Limited Character Sets and comments from member countries to Working Group K, Representations of Data Elements, for resolution and subsequent rewrite as a Second Draft ISO Proposal.

- To change the title of Working Group K from Data Elements and Their Coded Representations to Representations of Data Elements and to approve the following scope and program of work in this area :

Scope

The Standardization of the representation of commonly interchanged data elements to facilitate information interchange and information processing.

Program of Work

1. To develop international recommendations for describing data elements and their representations involved in data interchange.

2. To develop international recommendations for representing data elements of common interest to include representations for:

- a. Dates and Time
- b. Countries
- c. Languages
- d. Identification of Individuals
- e. Identification of Organizations
- f. Identification of Accounts
- g. Mailing and Shipping Addresses
- h. Point Locations, such as longitude and latitude
- i. Units of Measure
- j. Numeric Expressions

3. To develop recommended guidelines and criteria to provide for an orderly approach to the standardiza-

tion and description of data elements involved in international information interchange.

4. To provide liaison with other organizations and ISO Committees for the coordination of data standards intended for information interchange.

- To request Subcommittee 3, Character Recognition/Working Group 1—Optical Character Recognition, to consider technical difficulties detected by the United States in ISO Draft Recommendation 1831 (Printing Specifications for OCR—Optical Character Recognition). This draft recommendation was in the final balloting process prior to submission to the ISO Central Secretariat for approval.

- To acknowledge the significant work done by ECMA (European Computer Manufacturers Association) on the standardization of the programming language PL-1 and the joint program of work on the subject envisaged by ECMA and the Composite Language Development Group of the American National Standards Institute and to invite ECMA to submit the results of this joint effort to Subcommittee 5, Programming Languages, in time for consideration at its next meeting.

- To recognize that the fast developing field of data processing gave rise to changes in direction and emphasis of the standards work and to direct that the Committee Secretariat (United States) review the subcommittees' programs of work to take account of these changes.

Robert Chollar, National Cash Register Company, of the United States was elected to serve as Chairman of TC 97.

The United States delegation to the meeting included: T. H. Bonn, Honeywell, Chief Delegate; Marvin W. Bass, UNIVAC; Robert W. Bemer, General Electric; John B. Booth, Teletype Corporation; H. R. J. Brosch, NBS; Richard J. Mindlin, National Cash Register Company; James L. Smith, IBM; A. H. Stillman, State University of New York; and Harry S. White, Jr., NBS.

The next meeting of ISO/TC 97 will be held in Italy at a time to be selected in the future.

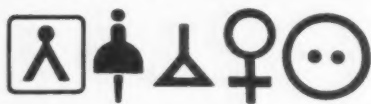
ISO HOPES TO RATIONALIZE SIGNS AND SYMBOLS

Closely related to the representation of information by coded characters is the representation of information by pictorial symbols. A new ISO committee has been proposed to work in this area.

Like musical notations, pictorial symbols can provide a form of universal language. Unfortunately, many symbols employed in one country often are unintelligible in another.

The Planning Committee of ISO therefore has recommended the establishment of a new Technical Committee to bring about international standardization of signs and symbols, and that the German Member Body of ISO be designated the secretariat. Subject to the approval of the ISO Council, the proposed new committee will recommend general principles for the preparation of new signs and symbols and the coordination of existing ones.

Thousands of symbols have been independently created by various groups for such diverse equipment as machine tools, calculating machines, washing machines, radios, and automobile controls. As an example, the following illustration shows five of the many designs symbolizing "woman."



Such confusing proliferation could be avoided by international agreement.

Various ISO Technical Committees have developed internationally agreed signs and symbols in special fields covering such things as pipeline systems in ships and aircraft, handling instructions for cargoes, flow-sheet diagrams for data processing equipment, and others.

The proposed new ISO Committee will strengthen the movement to rationalize and integrate symbols on a global scale. If an international system of signs and symbols is ultimately accepted, a traveller could immediately identify the rest room in any airport or railway station; a tractor operator would understand all the controls on any make of tractor; and a child would instantly recognize a sign indicating danger.

TELEPHONE INTERCONNECTION STUDY RELEASED BY FCC

A study on the problems involved in the interconnection of customer-owned equipment and telephone company services and facilities has been released by the Federal Communications Commission.

The study, Report of a Technical Analysis of Common Carrier/User Interconnections, was carried out by the Special Panel on Common Carrier Interconnections of the Computer Science and Engineering Board of the National Academy of Sciences (NAS). It was commissioned by the FCC to aid in evaluating questions raised by revised tariffs filed by telephone companies in response to FCC orders following the 1968 decision of the Carterfone Case. (Telephone company tariffs prohibiting interconnection of customer-owned equipment were declared invalid in the Carterfone Decision.)

In a letter, submitted with the report to the Commission, Anthony G. Oettinger, Chairman of the NAS Computer Science and Engineering Board, summarized the following principal technical findings of the study:

"1. Uncontrolled interconnection to the common carrier network as it now exists would be harmful.

"2. The requirements of the tariff criteria limiting characteristics of interconnected lines are technically based and in accord with the operational limits of the common carrier network as it now exists.

"3. The nature of potential harm, criteria for protection against such harm and the performance of various components of the telephone system can be specified explicitly enough to be understood and acted upon properly by people with normal technical competencies.

"Having found that harm of various kinds can occur and that technical limitations on interconnection are therefore necessary, the Panel studied protective measures. On the technical basis of the third set of findings, the study concluded that the following two approaches—used either alone or in parallel in such proportion as non-technical factors might determine—can supply the required degrees of protection for the network, including network control signalling:

"1. Protective arrangements as required by the tariffs.

"2. A properly authorized program of standardization and properly enforced certification of equipment, installation, and maintenance.

"Analysis of potential harm and protection capabilities revealed no technical reasons why innovation would be significantly restricted by either of the two approaches alone or in combination. The choice clearly impinges on economic and social problems and on questions of industrial structure which are beyond the purview of the study."

The study was conducted in conjunction with a series of technical and engineering conferences organized by Common Carrier Bureau Chief Bernard Strassburg to consider and, if possible, resolve issues raised about the telephone company tariffs. Lewis S. Billig, Technical Director of Communications of the MITRE Corporation, was Chairman of the NAS panel of experts carrying out the inquiry. Harry S. White, Jr., of the NBS Center for Computer Sciences

and Technology served as a member of the panel.

Copies of the Report may be purchased from the National Academy of Sciences, 2101 Constitution Avenue, Washington, D.C. 20418, for \$4.50.

CREDIT-CARD SPECIFICATION STANDARD APPROVED AT COMMITTEE LEVEL

A proposal that would provide for the standardization of credit-card specifications has been approved by ANSI Committee X4, Office Machines and Supplies, after nearly two years of work by Subcommittee X4A11.

This standard was developed under the procedures of ANSI, in response to wide interest expressed by credit-card manufacturers, users, equipment manufacturers, and others.

In the development of the proposed standard, the Subcommittee conducted surveys of the major credit-card issuing industries to determine characteristics and specifications of cards currently in use as well as future plans of the issuing companies. The airlines, banking, petroleum, and travel and entertainment industries surveyed accounted for about 95 million cards in use while retail merchants accounted for another 101 million cards.

The proposal includes: specifications for the credit cards; alternate specifications where name and address are required; alternate specifications for small size cards; and a credit-card account numbering system. Free copies of the proposed standard for public review and comment may be obtained from BEMA, 1828 L Street, NW., Washington, D.C. 20036.

ANSI PUBLISHES STANDARDS CATALOG

American National Standards Institute, Inc., has recently published its 1970 Catalog listing nearly 4000 American National Standards and 1700 international recommendations. An 18-page index to the titles of all listings is included.

Included in the expanded 128-page

edition are American National Standards approved by ANSI through January 15, 1970, and the international recommendations (standards) received by that date from the International Organization for Standardization, the International Electrotechnical Commission, the International Commission for Rules for the Approval of Electrical Equipment, and the Pan American Standards Commission.

The standards listed in the catalog include dimensions, ratings, terminology and symbols, test methods, and other criteria applicable to the entire industrial economy. Among the subjects covered are: civil engineering and construction; consumer goods; drawings, symbols, and abbreviations; electrical engineering; gas burning appliances; information processing; materials; materials handling; mechanical engineering; mining; motor vehicles; nuclear engineering; office equipment; petroleum products; piping and processing equipment; photography and cinematography; and safety.

Copies of the 1970 Catalog are available free of charge upon request to the American National Standards Institute, 1430 Broadway, New York, N.Y. 10018.

REVIEW OF R&D IN COMPUTER AND INFORMATION SCIENCES

Two recent NBS Monographs, by M. E. Stevens, are the first in a series of reports intended as a selective overview of research and development efforts and requirements in the computer and information sciences. The series will outline the probable range of R&D activities in these fields through reviews of the literature. In addition, it will attempt to reflect a consensus of workers in these and related fields as to areas of R&D concern for program planning. This series is entitled *Research and Development in the Computer and Information Sciences*.

The first volume is *Information Acquisition, Sensing, and Input—A Selective Literature Review*,¹ Nat. Bur.

Stand. (U.S.), Monogr. 113, Vol. 1 (\$1.50; SD Catalog No. C13.44:113/Vol. 1).

This monograph presents a selective review of the literature on the operations of information acquisition, sensing, and input to information processing systems considered in general terms. Specific topics include: source data automation and remote sensing techniques, communication systems and data transmission links, audio and graphic inputs, preprocessing operations upon input items such as image enhancement and property filtering, character recognition, speech recognition, and various other aspects of automatic pattern recognition. Supplemental notes fill about two-thirds of the volume and there is a bibliography of over 640 items.

The second volume in the series is entitled *Processing, Storage, and Output Requirements in Information Processing Systems: A Selective Literature Review*,¹ Nat. Bur. Stand. (U.S.), Monogr. 113, Vol. 2 (\$1.25; SD Catalog No. C13.44:113/Vol. 2).

This monograph deals primarily with R&D implications involved in the receipt of processing service requests from system clients and in the management of the processing operations themselves, with efficient and economical storage, with output considerations, and with post-processing operations on output.

Special emphasis is placed on multiple-access systems. Problems of system management and control are discussed; and attention is given to facsimile, digital, and mass random access storage media and techniques. A variety of output mode requirements are also examined, including: direct recording to microforms; on-line display systems; printing, photo-composition, and automatic character generation; and three-dimensional, color, and other special-purpose display systems. Problems of system use and evaluation are noted briefly.

¹ Order by SD Catalog Number from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402, for the price indicated.

CONFERENCE *Briefs*

FEDERAL OPERATIONS RESEARCHERS MEET COUNTERPARTS

The Bureau was host on May 7-8 to the Third Joint Meeting of Operations Researchers in the Federal Government and the private research sector. The Meeting was sponsored by the Bureau and cosponsored by the College on Logistics of The Institute for Management Sciences (TIMS), the Washington, D.C., Chapter of TIMS, the American Institute of Industrial Engineers, the American Society for Cybernetics, the Washington Operations Research Council, and the Washington Statistics Society. The purpose of the gathering was to open communications among operations researchers in and out of Government, using case studies of Federal policy as the educational vehicle. The Meeting featured panel discussions instead of papers; comments and discussion from the floor were an essential part of the program.

The Meeting was opened by Roy Herrmann, of the George Washington University Department of Management Science. Following, W. E. Cushen, of the Bureau's Technical Analysis Division, introduced panel discussions of four areas in critical need of decision and action. The first was on assessing the Nation's water resources; it was chaired by Paul L. Holm, Chairman of the U.S. Water Resources Council. The panel presented the concept of a water "budget," in which both income and use had to be balanced.

In the panel on how education affects students and student achievement, Chairman Willard I. Zangwill,

of the Department of Health, Education, and Welfare, called for comments on how to evaluate educational programs. Questions asked were, "What do we know about evaluating educational programs?" and, "Do we really learn more outside of school than within?" Each of the panelists analyzed these questions from a different perspective.

The pressing need for postal reform was stated by a panel chaired by the Hon. Ronald B. Lee, Assistant Postmaster General for Planning and Marketing. The three panelists, present and past members of the Postmaster General's staff, took cognizance of the recurrent crises in the Department and of the essential differences between a Cabinet agency and a business.

The growing ailments of transportation within the Northeast Corridor, stretching from New Hampshire through Virginia, were discussed by a panel recruited from industry, government, and academe under Chairmen Robert Nelson and Paul Shuldiner, formerly of the Office of High Speed Ground Transportation. This project had been charged with analyzing the interactions between transportation and the structure of the Corridor, forecasting transportation demand, and describing transportation services that would meet the demand, including transportation modes not yet used by the public.

1970 STANDARDS LABORATORIES CONFERENCE HOSTED BY NBS

The National Conference of Standards Laboratories held their biennial meeting at the Gaithersburg, Md.,

facilities of the National Bureau of Standards, June 15-17, 1970. With a theme of "Innovative Metrology—Key to Progress," over 20 papers were presented relating to improved techniques and procedures applicable to standards laboratories.

The National Conference of Standards Laboratories is a nonprofit laboratory-oriented organization whose purpose is to promote cooperative efforts toward solving the common problems faced by standards laboratories in their organization and operation. The organization was established in 1961 under sponsorship of NBS and presently consists of approximately 220 members—commercial, military, state, and Federal standards laboratories.

Dr. Lewis M. Branscomb, NBS Director, pointed out in his opening address that better measurements, and thus better calibration techniques, are becoming increasingly important in areas related to controlling the environment, such as pollution. He also cited recent innovations at NBS that have advanced measurement science; included among these were the methane-stabilized laser for length measurements and the use of television frequency channels to allow local receivers to synchronize more precisely with WWV broadcast time signals.

Dr. Myron Tribus, Assistant Secretary of Commerce for Science and Technology, spoke at the Conference banquet. Dr. Tribus emphasized that standards laboratories considering the need for innovation must balance the impulse to change against the disruption of the orderly routines that estab-

lish the precision of their output. He went on to say that performance criteria must exist for the operations of the standards laboratory, and cited the NBS Measurement Analysis Program (MAP) for mass calibrations as one that looks at the whole measurement process with sufficient redundancy introduced into the system to provide a concise, quantitative, and continuing evaluation of its operation.

The remainder of the meeting consisted of five sessions, the first of which dealt with new technologies and applications. Discussed were two computer automated systems for calibrations or tests, a self-balancing rf bridge, and a radiological mensuration technique for turbine blades.

In the second session, Laboratory Management and Operations Reports, recent committee work was described. One project reported on was measurement agreement comparison in which innovations to round robin measurement programs were discussed; the beginning of a round robin in acceleration, in which 20 members are currently participating also was announced.

In another project, results of a preliminary survey on a cost-visibility exchange program showed that 60 percent of the million calibration and maintenance hours reported were spent on just nine groups of instruments. The committee set for itself the goal of saving NCSL members one million dollars by 1972.

Another committee chairman told of examining 29 government specifications dealing with calibration requirements. His group is endeavoring to develop a new specification containing the minimum essential requirements.

The third session was concerned with calibration intervals and methods of optimizing them. An analytical method to evaluate equipment calibration intervals and provide justification for recommending changes based on the cumulated results of past calibrations was presented. Another speaker dealt with the use of calibration histories of families of instru-

ments to provide data on how often the instruments were recertified and whether each was in calibration when recertified. These data then permit the calculation of an optimum calibration interval for a desired level of confidence in the instrument readings.

The fourth session covered new ways of managing. Described was a computerized data system to monitor instrument reliability and to isolate repetitive problem areas. Another talk pointed up the importance of a data system to keep abreast of the location and calibration status of the equipment in a company. The data can then be used to make a valid decision as to whether the equipment should be used, stored, or declared surplus. A unique quality assurance audit program used by the U.S. Air Force to evaluate their precision measurement equipment laboratories was also described. In the Air Force system, problems are given to test the ability of the laboratory technicians to work together as a team. Emphasis is placed on comprehension, original thinking, and measurement techniques rather than on resolution and accuracy to parts per million.

The final session was devoted to new international developments. Highlights of this session included a report on new developments in metrology in Germany and the use of the Josephson junction effect as a voltage standard at the National Physical Laboratory, Teddington, England.

The full proceedings of the 1970 Standards Laboratories Conference are being published by the National Bureau of Standards; their availability will be announced by NBS and NCSL. Additional information concerning the conference and other NCSL activities may be obtained from: NCSL Secretariat, Room A345, Physics Building, National Bureau of Standards, Washington, D.C. 20234.

SCHEDULED NBS-SPONSORED CONFERENCES

Each year NBS sponsors a number of conferences covering a broad range

of topics in science and technology. The conferences listed below are either sponsored or cosponsored by NBS and will be held at the Bureau's Gaithersburg, Md., facility unless otherwise indicated. These conferences are open to all interested persons unless specifically noted. If no other address is given, inquiries should be sent to the person indicated below in care of Special Activities Section, Room A600, Administration Building, National Bureau of Standards, Washington, D.C. 20234.

National Metric Study Conferences.

Sept. 21-25, Oct. 5-6, Oct. 12-13, Oct. 14-16, Oct. 27-29, and Nov. 16-20. Contact: J. Odom (NBS Office of Invention and Innovation). To be held at Department of Commerce Auditorium, Washington, D.C.

25th Calorimetry Conference. Oct. 19-22. Contact: E. Domalski (NBS Physical Chemistry Division).

4th Materials Research Symposium—Pyrolysis, Oxidation, and Burning. Oct. 26-30. Contact: L. A. Wall (NBS Polymers Division).

The Science of Ceramic Machining and Surface Finishing. Nov. 2-4. Cosponsors: Office of Naval Research; American Ceramic Society. Contact: S. J. Schneider (NBS Inorganic Materials Division).

Symposium on the Application of Computers to Environmental Engineering Design. Nov. 30-Dec. 2. Cosponsor: American Society of Heating, Refrigerating and Air Conditioning Engineers. Contact: R. Achenbach (NBS Building Research Division).

Flow—Its Measurement and Control in Science and Industry. May 10-14, 1971. Cosponsors: American Institute of Physics; American Society of Mechanical Engineers; Instrument Society of America. Contact: V. J. Giardina, Instrument Society of America, 400 Stanwix Street, Pittsburgh, Pa. 15222. To be held in Pittsburgh, Pa.

Summer Symposium in Analytical Chemistry. June 16-18, 1971. Cosponsor: American Chemical Society (Division of Analytical Chemistry). Contact: R. A. Durst (NBS Analytical Chemistry Division).

Fifth Symposium on Temperature Measurement and Control in Science and Industry. June 21-24, 1971. Cosponsors: American Institute of Physics; Instrument Society of America. Contact: H. H. Plumb (NBS Heat Division).

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